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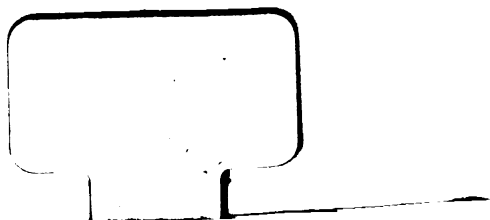
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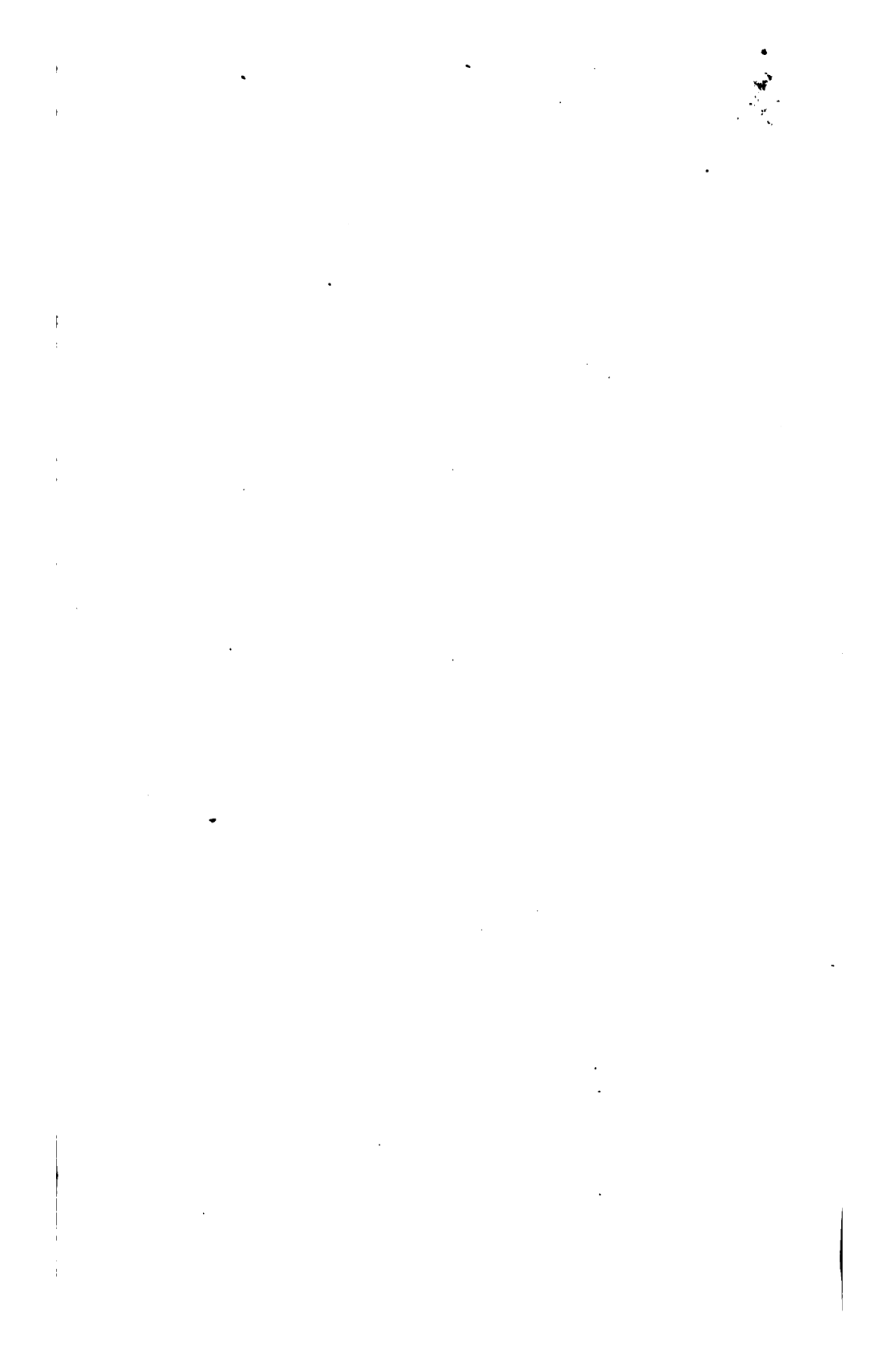
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HUXLEY
ON THE
LAWS OF MOTION

SIEMENS
ON
THE SUN'S HEAT

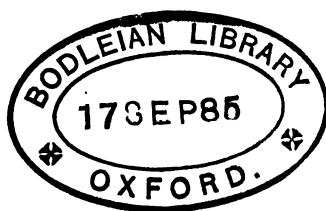
BY
WILLIAM LEIGHTON JORDAN, F.R.G.S.

LONDON
DAVID BOGUE, 3, ST. MARTIN'S PLACE
TRAFALGAR SQUARE

1882

1906.e.g.

1925.e.g.



HUXLEY ON THE LAWS OF MOTION.*

I.

LET a ball be projected from a cannon in a horizontal direction, or let a jet of water be projected from a horizontal pipe, with a force equal to that of the earth's gravitation. And suppose the air to be removed, so that the projected body may move in empty space.

Under such circumstances, according to the laws of motion invented and gradually systematized by Galileo, Descartes, and Newton, the projected body held in equilibrium between the centrifugal force of its momentum and the centripetal force of the earth's gravitation, would circulate for ever round the earth.

The reason why it was asserted that, under such conditions, the momentum of the moving body would keep it in motion for ever, was simply because there appeared to those philosophers no other way to account for the earth's continuous motion round the sun, nor for the moon's continuous motion round the earth.

I have, however, shown :—

First: That the gravitation of such a projected body would retard its motion; and that its momentum would therefore sooner or later be spent, leaving it to fall to the surface of the earth.

Secondly: That the sun's gravitation supplies not only the centripetal force which holds the earth in its orbit, but also the motive force, which latter is ceaselessly acting and carrying it onwards along its orbit.

And, thirdly: That a retarding force of astral gravitation which resists the earth's motion, and not directly the motion itself, is the centrifugal force which counterbalances the centripetal force of the sun's gravitation.

These discoveries stand unrefuted; and supposing them to be irrefutable, they obviously leave Newton's first law of motion no

* Published in the *Buenos Ayres Herald*, February 1, 1881.

raison d'être; for that law was invented for the sole purpose of explaining the fact of the earth ceaselessly revolving in its orbit without loss of velocity.

II.

A conflicting action of gravitation, similar to that which holds the planets in their orbits, I showed to be tending to cause a constant circulation in the ocean. And I traced out elaborately the course of the circulation which that action of gravitation tends to produce.

At a meeting of the Royal Geographical Society, as reported in the "Proceedings," issued April 17, 1869, pages 105 and 111, the late Mr. A. G. Findlay said these views regarding oceanic circulation were deserving of much attention, as very satisfactorily explaining what had never before been well accounted for. But Professor Huxley, disregarding the point of Mr. Findlay's suggestion, made a most absurd and unjustifiable misapplication of my views, and declared them to be so singularly at variance with what we know of ordinary physical laws that they could not stand their ground for a moment.

Though I renounce Professor Huxley's application of my views, they nevertheless certainly are utterly at variance with what he supposed to be ordinary physical laws. On this point the Professor was perfectly right. And, as I was six thousand miles from London at the time, the new physical laws, condemned by Professor Huxley, had then no supporter; for (as he afterwards informed me) Mr. Findlay supported my views simply because he saw that they so easily explained numberless facts of oceanic circulation as to make it evident to him that I must, in some manner, be right; though he had not succeeded in understanding the theoretical questions at issue.

III.

Professor Huxley's pronounced hostility to the new discoveries and championship of the old ideas, gave special interest to the announcement of a small introductory treatise on physical science being in course of preparation by him. It seemed to me that in such a work the learned Professor must either make a concise exposition of the old philosophy or else openly abandon it for the new; for an Introduction to Science could scarcely be expected to leave the most ordinary physical laws unenunciated. Twice, in the course of the past five years, I have been disap-

pointed whilst in London by the non-appearance of the book after its formal announcement. It has, however, at length, in the course of the past year, made its appearance, and I have opened it for the purpose of ascertaining what this worthy representative of the Royal Society has to say regarding the so-called laws of motion.

I regret to find in Professor Huxley's book neither a candid acceptance of the new, nor a definite exposition or defence of the old philosophy. Nevertheless, though the laws of motion are not definitely enunciated, it was not possible for the subject to be avoided in such a treatise; and, consequently, under the heading, *The Momentum of Moving Water*, when alluding to a jet of water projected from a horizontal pipe, Professor Huxley says:

"If, when the water leaves the tap, the air and gravitation were alike abolished, the water keeping its momentum, would travel for ever in the same direction."

Now, all I have contended for, in contradistinction to the old theory, is that the existence of the force of gravitation makes it impossible for the momentum of water, set in motion as above, to keep it in motion for ever; whereas, according to the old theory, notwithstanding the action of gravitation, the momentum of the water, if projected with the requisite initial velocity, would keep it in motion for ever; whilst gravitation would merely change the direction of motion from a straight to a curve line.

It is on this special question of the projection of a body in a horizontal direction that I have attacked the philosophy of Galileo, Descartes, and Newton. And in dealing with the subject Professor Huxley has made his statements in such a manner as to accord with the new views I have published; and has refrained from attempting to sustain the first law of motion as expounded by Newton.

I protest against the manner in which that first law of motion has been abandoned by Professor Huxley when dealing with this subject.

Let it be remembered, in the first place, that every orthodox astronomer, from Galileo to the present generation, has accepted that first law of motion; and it is not expedient in the interests of philosophy that their opinion on so important and fundamental a question should be departed from or ignored by a representative member of the Royal Society without the reason being explicitly given.

And, secondly, let it be remembered that in 1868, the Royal Society, whilst Professor Huxley was one of the secretaries, rejected a Paper in which I remodelled the theory of the tides as required by the newly discovered action of astral gravitation, and the consequent rejection of the law in question; that in

1869, Professor Huxley publicly declared at a meeting of the Royal Geographical Society that my views were untenable: and that, in 1877, he refrained from accepting a public challenge to discuss the question, which I issued to the Royal Society in general and to him personally.

Under these circumstances I say that the manner in which Professor Huxley has deserted the first law of motion whilst dealing with the horizontal pipe, and has made his arguments accord with my views without any acknowledgment of having been influenced by me, is unworthy of the Royal Society.

When, in 1866, Sir John Herschel informed me that in view of the firm conviction I entertained of the correctness of my opinion, it was right that I should appeal to "the mass of mankind" on the subject, I did not hesitate to accept the taunting provocation to enter the lists against the whole array of the Royal Society; but when I did so I took it for granted that no leading member of that Society would hesitate to make an acknowledgment as soon as he found himself convinced by my arguments. Will Professor Huxley prove that I have been mistaken on this point? Or will he attempt to prove that I have been mistaken regarding the laws of motion? Or will he acknowledge that the Royal Society have been mistaken in the hostility they have displayed against me?

Utrum horum maris accipe.

IV.

Having, under the heading, *The Momentum of Moving Water*, dealt with the problem of a jet of water projected from a horizontal pipe, Professor Huxley passes on to the heading, *The Energy of Moving Water*, under which he deals with the problem of a jet of water projected from a vertical pipe.

I have never directly attacked the explanation which has hitherto been accepted regarding the action of forces in this latter instance. I have refrained from touching that explanation, simply because the errors of the laws in question are less apparent, or only partially apparent in it. It has, however, now become requisite for me to deal with the subject for two distinct purposes.

In the first place: Professor Huxley, whilst correctly, though only partially, explaining the action of forces in this second instance, has by incidental allusions committed himself to the erroneous opinion which he carefully abstained from defending when dealing directly with the horizontal jet.

Thus, though the citadel directly attacked by me has been abandoned by Professor Huxley, he has nevertheless taken refuge in the outworks, and the position which he has there assumed makes it seem quite possible that he thinks the citadel may, in some manner, be recaptured, though he has neither been able to defend it, nor does he see where any reasonable attack can be made for the purpose of recapture. I must, therefore, follow the worthy champion of the Royal Society to those outworks in order to give him a *coup de grâce*.

And secondly: I must also now deal with the problem of water projected from a vertical pipe, for the purpose of showing how it is that the new philosophy is not so much at variance with the old regarding the explanation of this phenomenon as regarding the projection from the horizontal pipe.

I will go at once straight to the root of the question at issue by taking the second purpose first.

V.

Assuming that a body projected in a horizontal direction, with an initial force of momentum equal to the force of the earth's gravitation, would continue for ever to revolve about the earth, held in equilibrium between the two forces; let the force of projection be less than that of the earth's gravitation. Then, as the body inclines towards the earth under the action of the greater force, it is obvious that, the force of momentum remaining the same whilst that of the earth's gravitation increases every instant, the body must approach the earth with a downward velocity every instant increasing. If, however, the force of projection be greater than that of the earth's gravitation, the same argument requires that, as the distance of the projected body from the earth increases under the action of the greater force and the force of the earth's gravitation is therefore every instant less, the body must recede from the earth with an upward velocity every instant increasing, and thus continue to recede *ad infinitum*.

Common sense and practical necessity have, however, always prevented a logical enforcement of the first law of motion in any case in which the momentum of a body increases its distance from the earth. It being practically apparent that the momentum is then spent, the logical enforcement of the law in this case would be its *reductio ad absurdum*. And just as the law was accepted as a practical necessity for the purpose of explaining the continuous motion of the earth and for the purpose of supplying

a counterpoise to the centripetal force of the sun's gravitation, so also its purely logical enforcement was prevented by the practical necessity of preventing its action from requiring the bodies of the solar system to be continuously receding from the sun.

I say that, if the force of initial momentum equal to the earth's gravitation were not gradually spent by constantly endeavouring to carry a body away from the earth in a horizontal line whilst gravitation as constantly drags it down from that line ; then, a force of momentum sufficient to break away from the earth's gravitation at any given distance, could not be restrained by the lesser forces of gravitation beyond.

Or, on the other hand, if the force of momentum endeavouring to carry a body away from the earth in a vertical, or in an inclined line, is gradually spent by the resistance of the earth's gravitation ; then, the force of momentum, tending to carry a body away from the earth in a horizontal line, must, also, be gradually spent by the resistance of the earth's gravitation.

The reason why these simple arguments have been disregarded is because it is a mere matter of fact that, in the motions of the planets, the average horizontal motion is not retarded, whilst upward motion is gradually retarded, and then changed to downward motion, and the so-called laws of motion are an incongruous piece of patchwork invented to fit those facts. In vertical motion the laws are handled as if dealing with a common cannon-ball ; and, in horizontal motion, as if dealing with a rocket, not only carrying within itself an inexhaustible supply of motive power, but also endowed with an impossible power of every instant changing its direction of projection to suit those laws.

Let us now consider the position assumed by Professor Huxley.

VI.

"Observe," says the Professor, "the difference between the vertical jet of water and the horizontal jet. If we leave the resistance of the air out of consideration, the water in the horizontal jet has no obstacle to overcome ; and it might go on for ever, if its weight did not gradually cause its path to become more and more bent towards the earth, against which it eventually strikes.

"When the jet is vertical the case is altered. The water thrown up vertically, constantly tends to fall down vertically, as any other heavy body would do, and its momentum has to overcome the obstacle of its gravity."

And further on the Professor says :—

"It is obvious that, however great the disproportion between momentum and gravity to start with, gravity must gain the day in the long run under these circumstances. The store of momentum will be used up; and, after a momentary rest, the water, reduced to the condition of a body without support, will begin to be carried downwards by the unopposed action of gravity."

Professor Huxley thus applies to the vertical jet the same arguments which I have applied indiscriminately to the horizontal, the vertical, and the inclined jet. But whilst doing so the Professor makes a show of supporting the first law of motion which he had carefully abstained from defending whilst dealing with the horizontal jet, which was the point I attacked when exploding that law of motion.

Professor Huxley first asserts that the weight of the water is no obstacle to its motion when projected from the horizontal jet; but, in the same sentence, he practically admits that it is an obstacle. The sentence is peculiar, seeing that the weight is nothing but the force of gravitation, and seeing that I have pointed out that the momentum becomes spent by the ceaseless resistance of that force of gravitation whether the water be projected from a vertical, an inclined, or a horizontal jet.

Up to this point, however, the Professor had not distinctly committed himself to the first law of motion, or, to be more exact, having first definitely committed himself, he quickly corrects himself in the same sentence; but then he goes on to say: "When the jet is vertical the case is altered—and its momentum has to overcome the obstacle of its gravity."

This, though an indirect, is nevertheless a definite assertion to the effect that gravity is no obstacle to the momentum from the horizontal jet.

I am not surprised at Professor Huxley having made no definite defence of the first law of motion; but considering the general tenor of his book, I am surprised at his committing himself to it by this incidental allusion instead of clearly perceiving that it has become an exploded fancy.

If, as Professor Huxley asserts, in the case of the vertical jet, "the store of momentum will be used up," and "the water, reduced to the condition of a body without support, will begin to be carried downwards by the unopposed action of gravity," how can it be denied that, in the case of the horizontal jet, in which the water begins to be carried downwards, by the force of gravity, from the horizontal line of projection immediately it leaves the pipe—how can it logically be denied that under these circumstances also the store of momentum will be used up and leave the body to be carried more and more downwards?

VII

All astronomers, from Galileo to Herschel, assume that an initial force of momentum acting in a straight line across a given force of gravitation might give a never-changing equilibrium of forces, causing an endless revolution in a curve line; because no other explanation than that assumption was found to account for the earth's continuous motion.

But now that the true cause of the earth's motion has been discovered, that assumption is no longer wanted; and, moreover, Professor Huxley's arguments, as above shown, make that assumption logically untenable as far as he is concerned. For, if the store of momentum is gradually used up (those are Professor Huxley's words) by the force of gravitation which resists the upward momentum in the vertical line, how, in the name of common sense, can it be logically contended that the store of momentum will not be used up by the still greater force of gravitation which ceaselessly resists the upward momentum in the horizontal line?

DR. SIEMENS ON THE CAUSE OF THE SUN'S HEAT.*

"Thrice is he armed that hath his quarrel just."

WILL you please kindly allow me space in your columns to expose the unfair play to which I have been subjected, and of which I have been made aware by a translation of a leading article from the *Times* which has appeared in the *Nacion* this morning.

In order to make the question clear, I must first give you some extracts from "The Winds," a work published by me in 1877, and afterwards some other extracts from the article above mentioned, which has driven me almost wild with indignation.

In the tenth chapter of the work above mentioned I wrote as follows :—

"The foregoing chapters have led us, through arguments which are nothing more than a simple application of the Newtonian laws of gravitation, to conclusions which show that the existence of the Cartesian vortices is a mere matter of fact. The question as to whether these vortices are vortices of fluid matter or merely vortices of force, is a secondary question, with which our arguments thus far have not been concerned. For the laws of gravitation and the theory of *vis-inertiæ* based on them are not concerned with the question as to whether the spaces between the heavenly bodies are an 'empty void' or are filled with a transparent fluid. But, on the other hand, the accepted laws of motion are at variance with the idea of the existence of any resisting medium in the spaces through which the planets move, for these are supposed to move by virtue of a 'primary impulse,' which would gradually be retarded by the action of any resisting medium about them.

" If the vortex be not only a vortex of force, but of fluid matter, as asserted by Descartes, and light be undulations of that matter, then the sun's rays must almost

* The two following letters appeared in the *Buenos Ayres Herald* on April 30, and May 11, 1882, respectively under the heading THE ROYAL SOCIETY.

necessarily revolve with the vortex, as suggested by the above considerations.

"This latter is strong evidence in favour of Descartes' opinion. And, supposing the suggestion to be valid, even though the heat about the earth's surface is created by the conflicting action of terrestrial gravitation with the sun's rays, we cannot, as far as the foregoing arguments are concerned, assume that the reaction of the planets on the sun must cause a similar creation of heat on its surface.

"It is, however, reasonable to assume that the inter-action between the sun and other stars must be reciprocal, whether that action cause a reciprocal creation of heat about each one or have some other effect. . . . And it seems most reasonable to assume that heat is the primary creation of the friction of matter caused by the rotation of the stars, and that light emanates from that heat. If this be so, then an insufficient velocity of rotation alone prevents terrestrial gravitation from being transmuted into light."

The foregoing was, as already stated, published in 1877. I will now give the unfairness, as it appears in the columns of the *Times*.

"What keeps the majestic ball hot and bright? This has greatly engaged physicists and astronomers, and various have been their theories. . . . One view has been that the steady contraction of the sun's volume by gravitation produces the enduring glow. Another, favoured by Mayer, and Sir W. Thomson, was that the orb is perpetually pelted by meteoric and cometic matter, drawn into it by its mass, which keeps the temperature up by friction of tremendous blows, and the chemical energy aroused by amalgamation. . . . It is very kind, therefore, of Dr. Siemens to come forward with an entirely new theory. . . . He supposes interstellar space to be filled with an extremely attenuated hydrogen, and interplanetary space with denser gas, albeit more rarefied than the atmosphere drawn around each world. The sun, he thinks, whirling on its axis, draws into its poles the thin hydrogen, hydrocarbon, and oxygen of our sphere, and these being kindled are projected outwards at his equator into space."

In the first place, the broad distinction between Dr. Siemens' theory and previous ones is, that instead of the sun's heat being caused by the downfall of meteoric stones, or by the sun's contraction, it is caused by the sun's rotation; and this main point of the theory is merely what I have for years been asserting, as shown in the extracts I have given above. Dr. Siemens, therefore, has not brought forward an "entirely new theory,"

but has merely accepted one-half of the conclusion arrived at by me, long ago, in the words:—

“Whatever the heat-evolving action of the sun’s contraction may be, it is an absolute certainty that the action of astral gravitation, which resists the sun’s axial rotation, causes a strain and friction in the sun which also tends to produce heat and light.”

It is preposterous to suppose that just because Dr. Siemens may be unable to understand the action of astral gravitation, he is, therefore, entitled to appropriate to himself the honour of the discovery of the fact of the sun’s heat being caused by its axial rotation. That discovery was announced by me many years ago, as above shown, and therefore is not now a new discovery made by Dr. Siemens.

As the action of astral gravitation first showed that the sun’s axial rotation must create heat, and that the existence of the vapours or gases circulating around the sun must almost necessarily be a consequence of that action, astral gravitation is less likely than any other part of the theory to be proved erroneous.

Secondly: In assuming that interstellar space is filled with a rarefied gas Dr. Siemens is merely adopting the opinion of Descartes, which I have over and over again insisted to have been unnecessarily rejected by Newton and all who have since been regarded as orthodox philosophers.

Thirdly: Unless Dr. Siemens has by mathematical demonstration proved that the natural effect of the sun’s “whirling on its axis” would be to draw “into its poles” the “thin hydrogen” supposed to surround the system, I must assume that he is mistaken, for I long ago gave a mathematical demonstration to show that the effect of such a body “whirling on its axis” would be to draw any such surrounding fluid down to its surface, not at the poles, but all round zones intermediate between the poles and the equator; and that demonstration remains unrefuted.

Fourthly: Dr. Siemens and all members of the Royal Society know perfectly well that the idea of any material substance, however attenuated, pervading interstellar or interplanetary space is irreconcilable with the Newtonian laws of motion. I ventured on the bold enterprise of reinstating Descartes’ opinion on the above point only after proving the above mentioned laws of motion to be erroneous and replacing them by the new theory of *vis-inertiæ* and the action of astral gravitation. But the hostility of the Royal Society, and the ridicule heaped on me for denying the truth of those laws of motion, have excluded me from all scientific circles. Under these

circumstances, for Dr. Siemens or any leading member of the Royal Society to ignore those laws of motion and to base arguments on the supposition of their non-existence, without first making any acknowledgment to me, is unworthy conduct, which I refrain from characterizing in the terms it seems to me to deserve; and which, if not repaired, will leave a lasting stain on those who now appear as the leaders of the scientific world.

When I challenged the Royal Society in London, in 1877, I pointed out what appeared to be ungenerous conduct on the part of Dr. Siemens, but now Dr. Siemens seems to have discarded all regard for consistency or courtesy.

Since your publication on the 30th ult. of the letter in which I pointed out the appropriation of scientific discoveries indicated by a leading article in the *Times*, I have read an article in the *Nineteenth Century Review* on which the *Times* appears to have been commenting. It appears from that article that Dr. Siemens requires in interstellar space, for the purposes of his discoveries, the existence of a gas of $\frac{1}{1000}$ the density of our atmosphere. I should like, if you think well, to point out to Dr. Siemens, through the medium of your columns, what effect such a substance would have on the earth according to the laws of motion, in which he professes to believe.

It has been ascertained by careful experiments that a musket-ball, projected with an initial velocity of 1,670 feet per second, loses at least $\frac{1}{2}$ of its velocity in $\frac{1}{10}$ of a second. Allowing that the resistance to the ball is 2,000 times greater than to the earth in consequence of the greater density of the atmosphere through which it passes, and 7,744 times greater in consequence of the greater velocity of motion; that is to say, considering the resistance as the density and as the square of the velocity; a period about 15,500,000 times longer would be required to reduce the earth's motion in the same degree. Thus the retarding action of the fluid matter required by Dr. Siemens would, according to the "laws of motion," retard the earth in its orbit to the extent of $\frac{1}{2}$ of its velocity in about six days, even supposing it possible for the earth, according to those laws, to remain in its orbit in face of such an impediment to its motion. And the existence of this retarding medium is suggested in face of the fact that 2,000 years of observation from the Chaldean astronomers to Laplace showed no perceptible change of velocity or of the major axis of the orbit.

Is it not evident that the idea of space being filled with matter at all approaching the density required by Dr. Siemens is either itself ridiculous, or else makes those laws of motion ridiculous?

I do not pretend to consider it perfectly accurate to treat the retarding action as the density of the resisting medium and as the square of the velocity of the moving body, and I need not discuss the various modifications this estimate requires; for even supposing that I have under-estimated the difference as much as ever Dr. Siemens can make to appear at all reasonable, just let us consider what the result of even an immensely smaller retardation must be.

According to the "laws of motion" the effect of such a retarding action would not be a reduction of the absolute velocity of the earth's motion, but an absolute acceleration of the motion with such a change of its direction as to carry the earth towards the sun instead of along its former orbit; for the momentum imparted by an initial velocity exactly equal to the existing mean velocity is supposed to be the force which resists the sun's gravitation, and therefore, however slight may be the amount of retardation in the period of $\frac{1}{360}$ of a second, it results in a correspondingly slight fall towards the sun. And then, not only does the number of these slight falls increase as the time in consequence of the constant retardation of the orbital momentum, but also, with the diminishing force of resistance, the earth would be moving into a gradually increasing centripetal force, drawing it downwards at a velocity increasing as the square of the time; and therefore, between the decrease of the one force and the increase of the other, the amount of the falling motion would be increased as the cube of the time; so that the imperceptibly slight fall experienced in the $\frac{1}{360}$ of a second becomes in the course of the six days increased about 3,760,000,000,000,000,000,000 times, and in the course of the 2,000 years would be what for all practical purpose may be considered an infinite increase, or at any rate such an increase as must have brought the earth down to the surface of the sun in the course of a comparatively small fraction of the 2,000 years, however much Dr. Siemens may endeavour to explain away or minimize the retarding action of his gas of the $\frac{1}{10000}$ part of the density of our atmosphere.

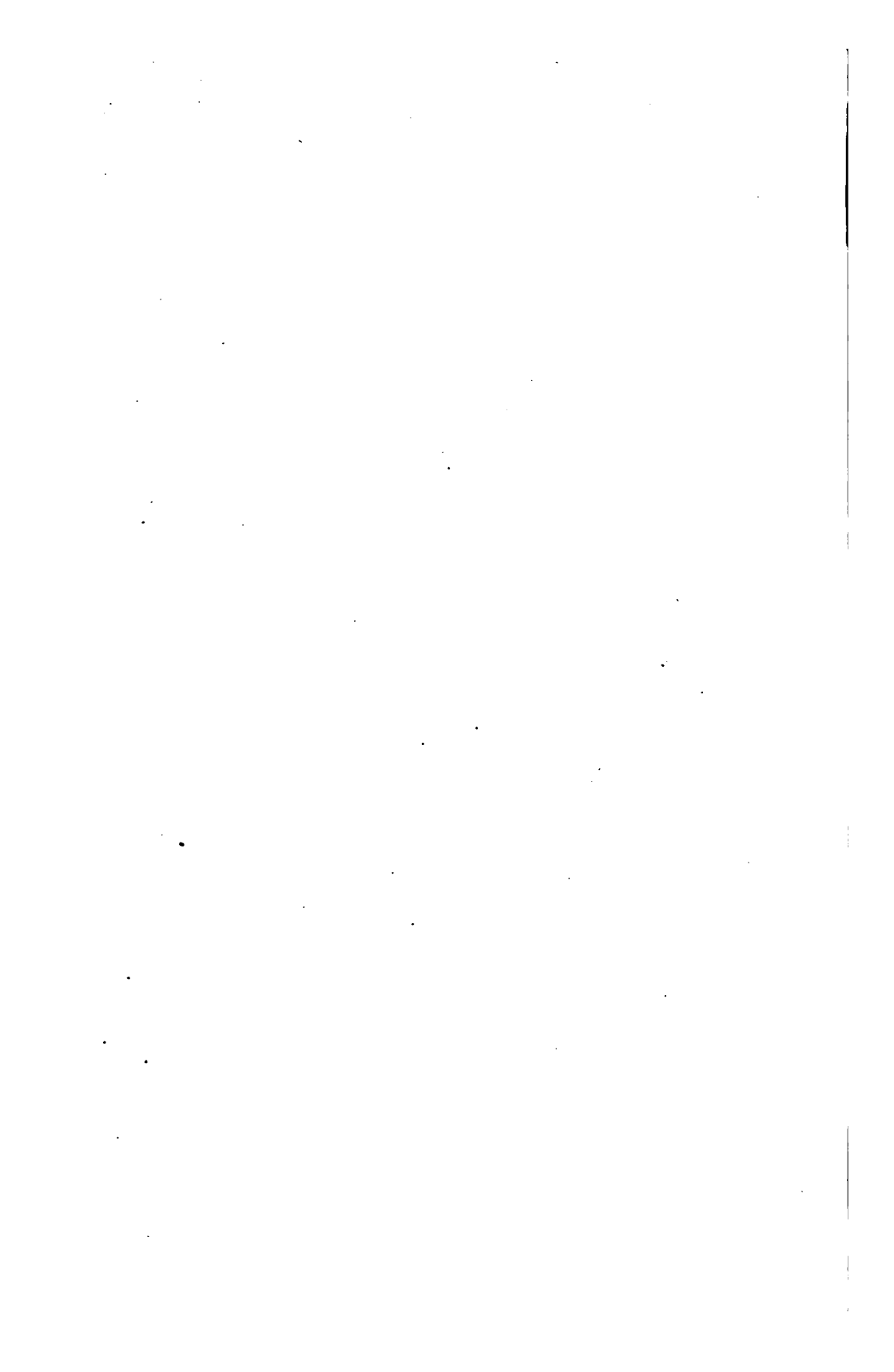
It ought to be obvious to every member of the Royal Society that to attempt to sustain the "laws of motion," as Dr. Siemens does, with the same penfull of ink which asserts the existence of such a gas extended through space, is an infinite absurdity, which now forms a practical justification of the conclusion I arrived at fifteen years ago, when criticising the

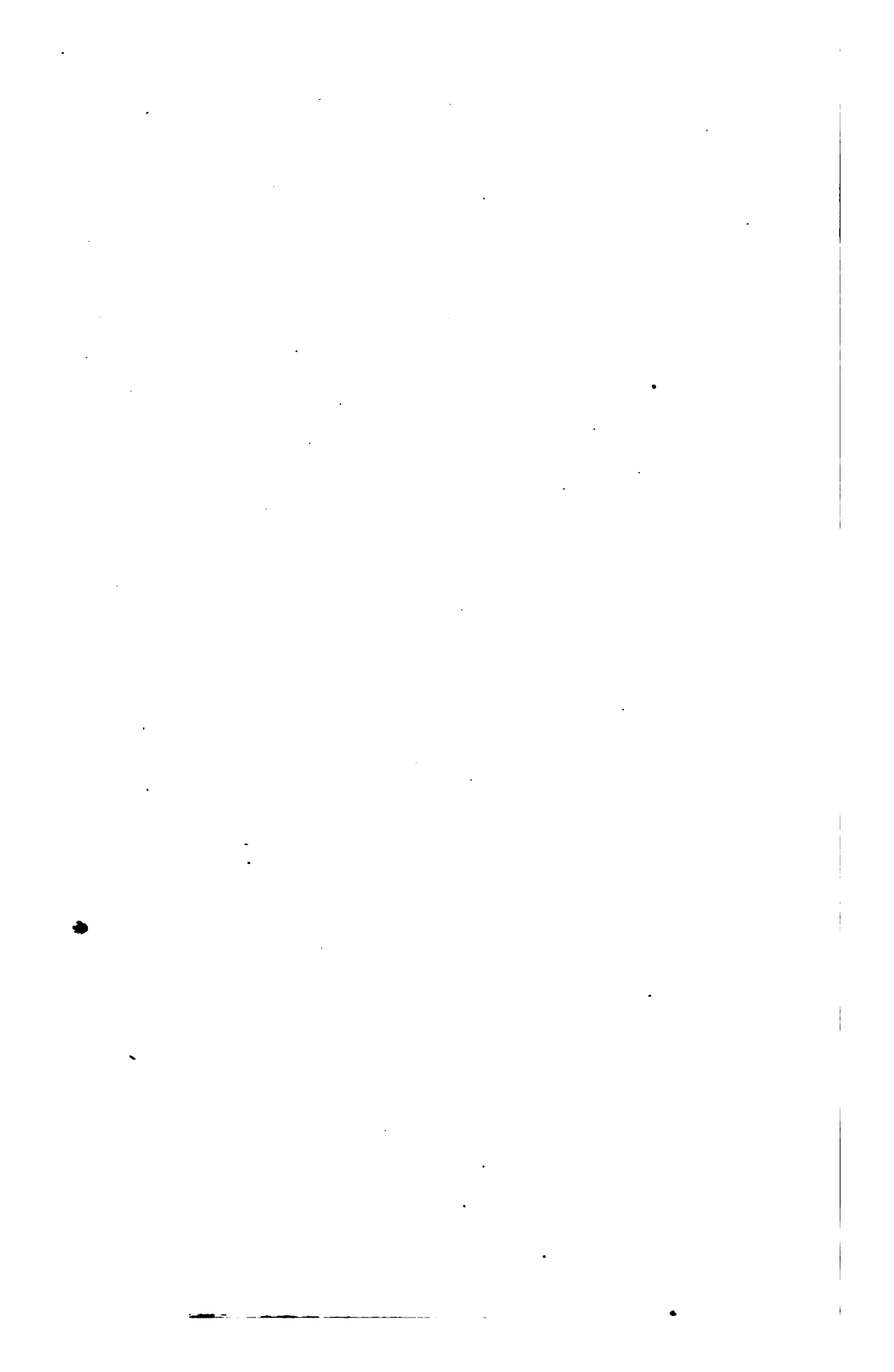
abstract arguments by which those "laws of motion" were established: "but for the weight of authority with which they are propounded no student could now fail to see their invalidity."

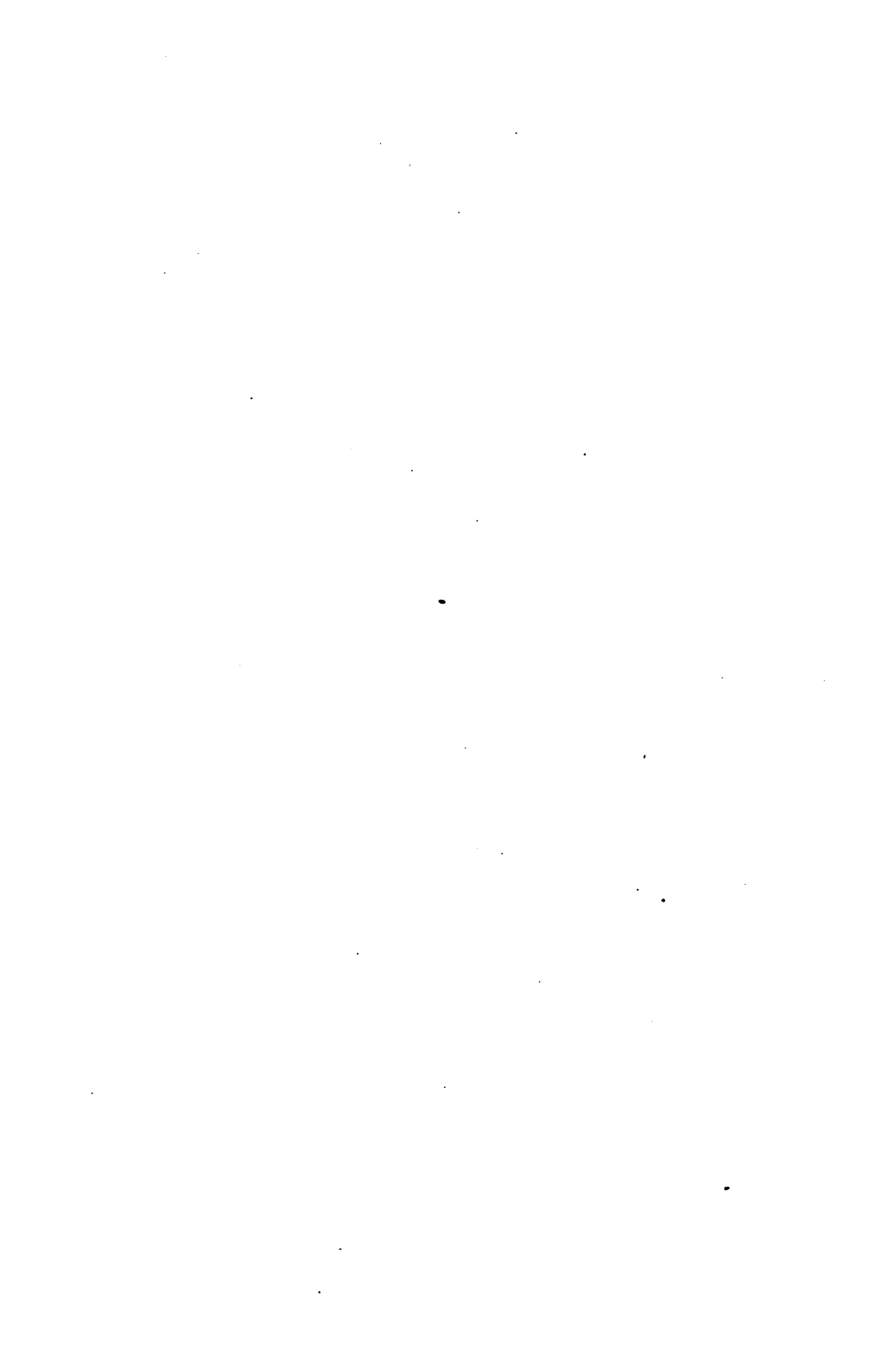
I have been ridiculed and slandered in consequence of having denied the truth of those laws, but it is now, I trust, becoming evident to any one who studies the question at issue that the ridicule, and worse than ridicule, is deserved by those who ridicule me, and, at the same time, announce broken fragments of my old discoveries as new discoveries just made by themselves.

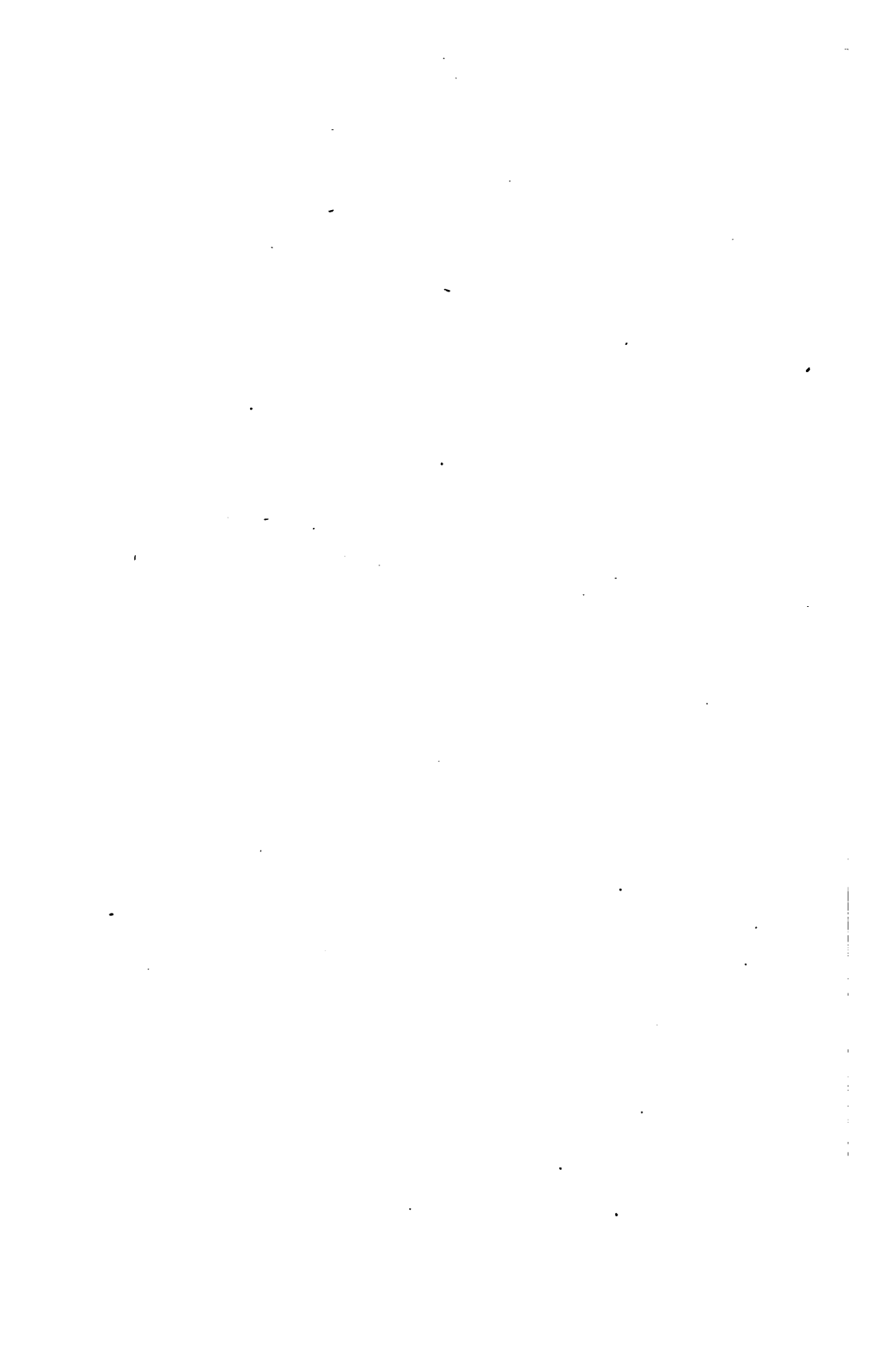
I have shown it to be a mere matter of fact that, in consequence of the action of astral gravitation, an increase of motive force would carry the earth further from the sun, where it would again move in equilibrium, with a *slower* motion than before; or a decrease of motive force would allow it to fall nearer to the sun sufficiently to restore the equilibrium, and it would then move with a *faster* motion than before. In each case the disturbed equilibrium restores itself. But under the Newtonian laws of motion a change of the motive force would cause the earth to move with a constantly accelerated motion either away from, or towards, the sun.

Please allow me to repeat what I said in my last letter to the effect that, for leading members of the Royal Society to ignore the Newtonian laws of motion and to carry on their investigations and "discoveries" according to the laws of astral gravitation, as several members of that Society are now doing, without any acknowledgment to me, is not fair play.











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